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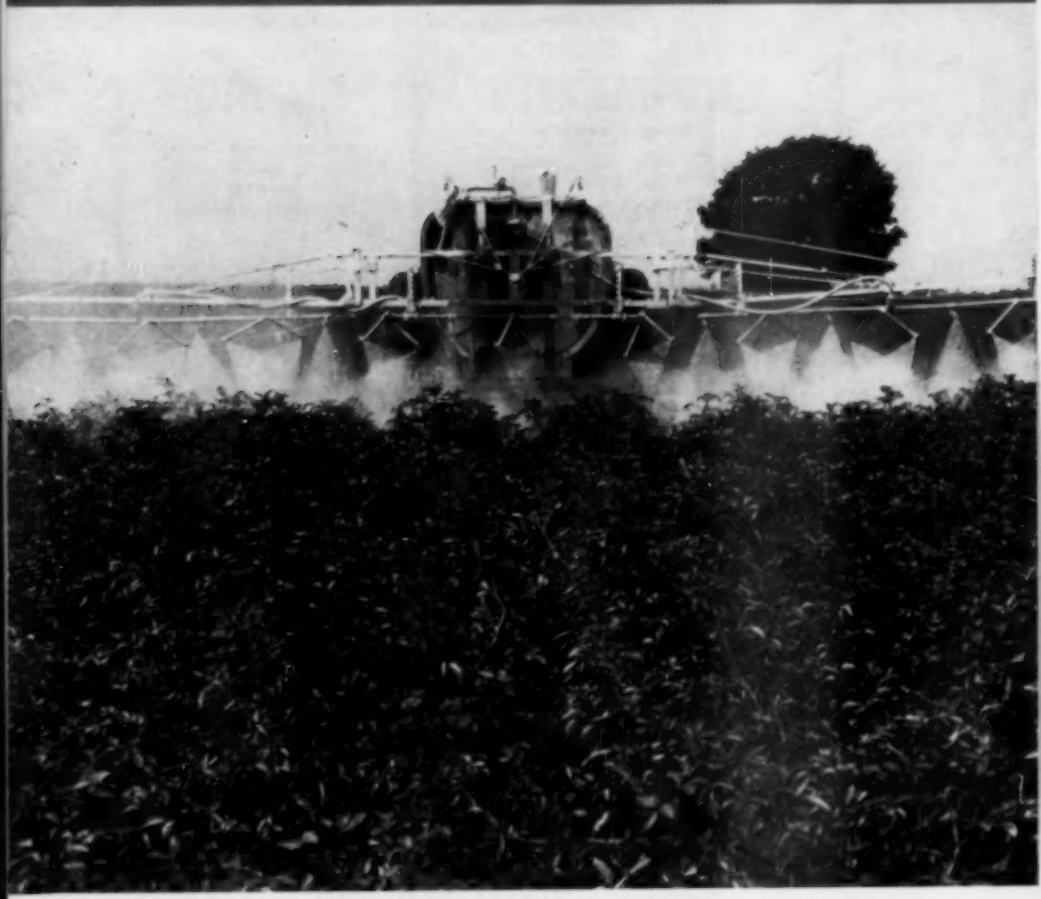

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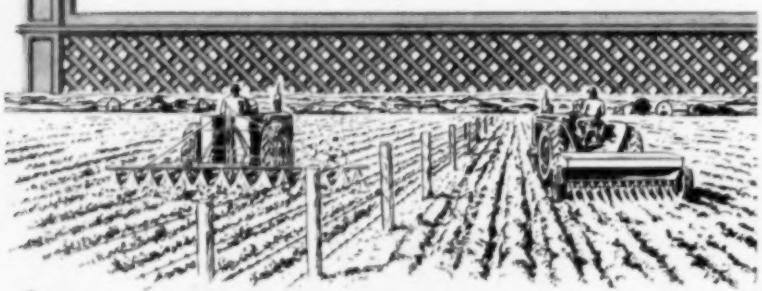

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CONTENTS

Potato Planting Rates with Dryland Culture in Western Nebraska —*H. O. Werner* 197

Potato Tissue Culture—*H. W. Chapman* 207

Effect of Intensity, and Width of Inter-Row Tillage on the Yield of the Potato Crop—*M. A. Moursi* 211

Reactions of Potato Varieties to Late Blight and Insect Injury as Reflected in Yields and Percentage Solids—*F. J. Stevenson, R. V. Akeley and R. E. Webb* 215

A Valuable Indicator Plant for a Strain of Potato Virus Y —*K. Silberschmidt and E. Rostom* 222

NEWS AND REVIEWS

Canadian Inspection Procedure—Table Potatoes—*P. W. Clement* 228

Announcement of Annual Meeting 235

OUR COVER PICTURE—*Thorough coverage of potato vines with insecticides and fungicides is essential for a good crop in many areas. Photo Courtesy Rutgers University.*

POTATO PLANTING RATES WITH DRYLAND CULTURE IN WESTERN NEBRASKA[1]

H. O. WERNER[2,3]

In the dry land areas of the western portion of the Northern Great Plains the planting of 10 to 16 bushels of potatoes per acre (1 to 1½ oz. pieces, 14.4 to 18 inches in the row) has been fairly satisfactory with the Triumph variety. With this rate of planting many tubers may be excessively large in years of high summer rainfall and conversely many may be very small in unusually dry summers. For the table market the larger size tubers over 2½ inches in diameter are most desirable, but for the seed market—a very important outlet—smaller potatoes are preferable. Experienced growers realize that with dryland potato culture it is never possible to choose the most desirable planting rate as can be done with irrigation culture, because of the great seasonal variation in the amount and timeliness of summer rainfall. However, it did seem desirable to determine the combination of seed piece size and planting distance which would produce best yields with tubers of the most desired size in most years.

The advent of the Progress variety—with some morphological and physiological characteristics quite different from those of Triumph, accentuated the planting rate problem. One important characteristic of Progress is its production of greater percentages of small tubers as a result of the propensity to grow more stems per seed piece and hence to set more tubers. Another is the somewhat greater likelihood of seed piece decay because of slower wound cork formation on cut surfaces of seed pieces. It was feared that the use of small seed pieces might bring about poor stands or weak plants and low yields because of the possibility that seed pieces would not heal rapidly enough to prevent decay. On the other hand, with large seed pieces such a heavy set of tubers might occur that most of them could be too small, especially in years of late summer drought. It seemed that the seed decay problem with Progress could be minimized by planting small whole tubers, but that then too many very small tubers might be produced. It is commonly known that with small whole tubers or pieces cut from small tubers there is considerable increase in the number of sprouts and tubers per seed piece.

EXPERIMENTAL METHODS AND SEASONAL CONDITION

With consideration to these various aspects, an experiment with the following planting distances and seed sizes was conducted on the Box Butte Experiment Farm near Alliance, Nebraska during the four seasons 1948 to 1951 inclusive:

[1]Accepted for publication January 12, 1955.
Published with the approval of the Director as paper number 685, Journal series, Nebraska Agricultural Experiment Station, Lincoln, Nebr.
[2]Department of Horticulture, University of Nebraska, Lincoln, Nebr.
[3]The field work from which the data for this paper were procured was under the immediate direction of the following supervisors of the Box Butte Experiment Farm: Kerwin Jantz (1945), H. W. Chapman (1946-1950), Jackson Davidson (1951).

Treatment Designation	Planting Distance	Average Seed Piece Weight	Average Bushels Planted Per Acre
A.	1.16 Ft.	2 Oz.	23.4
B.	1.16 Ft.	1 Oz.	11.8
C.	2.32 Ft.	2 Oz.	11.8
D.	2.32 Ft.	1 Oz.	5.9

The first of these planting rates (A) was expected to be excessive for all except very favorable years. The last was considered impractical for all except the driest years or as a method of assuring production of large tubers for table use and of getting the maximum return for each bushel planted. These are important matters, either when seed potatoes are very expensive or when it is desired to increase the seed stock of a new variety very rapidly. The intermediate planting rate (B and C), which is typical of common practice, was attained by using two extreme combinations of planting distance and seed size. Both Triumph (Nebraska strain 22) and Progress varieties were used. In addition, the experimental treatments were repeated with Progress by using small whole tubers carefully selected so as to be of the same size range as the cut seed pieces.

For the cut pieces, tubers were selected that would give the desired seed weight when cut into either 2, 3, or 4 pieces, with a variation of individual pieces from the mean weight of usually not more than 10 per cent. All seed was cut about one week before planting. The cut pieces were held under conditions favorable for inducing rapid wound cork formation. Planting period ranged from June 21 to 25 with an assisted feed Iron Age planter. Four randomized plots of two rows, 8 rods long, were planted with each treatment in all except one year when 8 such plots were used.

In this paper the results are reported for four years of the experiment (1948-1951) with Triumph and Progress varieties. The results from treatments B, C, and D with Triumph in the three earlier years, 1945 to 1947, for Progress in 1947, and for White Cloud in 1948, 1949, and 1950, were of the same general nature and are referred to very briefly.

The seasons can be classified according to their suitability for growing potatoes as having been:

Exceptionally favorable 1949;
Very good 1945, 1946;
Good 1948, 1951;
Fair 1950;
Poor ..... 1947.

On the whole, the seven-year period was more favorable than any seven-year period from 1931 to 1951 during which this farm had been occupied as an experiment station, or than the 51 years for which weather records are available at nearby Alliance (Table 1). In the best years there was adequate spring rainfall, cooler than average temperatures, and usually less than average evaporation and wind movement. Scarce or poorly distributed rainfall or higher temperatures were usually responsible for

TABLE 1.—*Climatic conditions during each of the summer months at the Box Butte Experiment Farm in each of the trial years, and the mean for 23 years ending with 1953.*

Year	Oct. 1 to May 31	June	July	August	Sept.	Total Crop Year	Total or Mean, 4 Months
			Inches of Effective Precipitation[1]				
1945	3.33	4.38	0.70	2.49	1.96	12.86	9.53
1946	4.03	2.95	.56	0	1.75	9.29	5.26
1947	3.03	6.30	.54	0	.82	10.69	7.36
1948	4.79	2.38	1.51	1.02	1.96	11.66	6.87
1949	7.17	2.49	1.42	1.92	0	13.00	5.83
1950	3.20	0	5.47	1.17	2.66	12.50	9.30
1951	2.30	1.06	2.27	.45	3.87	9.95	7.65
23 year mean[2]	5.19	2.60	1.03	1.14	0.84	10.80	5.61
			Average Monthly Temperature (°F)				
1945		57.2	71.3	70.1	57.2		64.0
1946		64.5	74.3	69.2	60.8		67.2
1947		61.0	73.2	75.3	62.7		68.1
1948		63.8	72.0	71.5	65.3		68.2
1949		64.3	74.2	71.8	59.2		67.4
1950		64.8	68.6	66.8	58.6		64.7
1951		57.8	69.6	69.0	56.3		63.2
23 year mean		64.6	73.3	71.3	61.0		67.6
			Average Wind Velocity—Miles per Hour				
1945		7.65	5.78	6.24	7.72		6.95
1946		7.22[3]	5.99	4.65	7.88		6.44
1947		8.60	7.03	6.60	6.91		7.29
1948		6.66	6.15	7.15	8.33		7.07
1949		6.33	6.49	6.29	6.71		6.46
1950		8.13	6.52	6.79	8.12		7.39
1951		7.95	6.39	7.13	7.34		7.20
23 year mean		7.58	6.45	6.41	7.20		6.90
			Inches Evaporation				
1945		5.68	8.87	8.07	6.94		29.56
1946		7.78	8.91	8.18	5.89		30.77
1947		5.56	8.03	9.64	6.94		30.17
1948		6.10	8.78	8.76	7.53		31.17
1949		5.27	10.30	9.20	5.74		30.51
1950		8.9	10.46	7.69	5.12		32.21
1951		5.4	7.62	7.84	5.78		26.64
23 year mean		7.66	9.78	9.16	6.61		33.20

[1]Effective precipitation 0.5 inch within two consecutive days.
[2]23 year mean based on years 1931-1953.
[3]Record incomplete—mean adjusted to thirty days.

the lower yields. The season of 1947 was very unsatisfactory because of soil-packing rains and excessive "run-off." As there was little summer rainfall that year the soil became so unusually hard that tubers were of very poor type. Severe hail storms in July and August wrought serious damage to the tops in 1950 from which many of the plants—especially those from the smaller seed pieces—did not recover effectively. In 1951

the vines were killed in early September by combined attacks of early and late blight.

The total yields for each variety (whole or cut pieces) were derived by weighing the tubers from each plot of each treatment at harvest time (about October 1) and then calculating the mean yields in bushels per acre from the treatment means. The total yields shown in table 2 for each variety and treatment are the means of the four annual means.

During early November the potatoes from all replications of each variety and treatment were composited for grading and sizing. The screen sizes were "A"—over 1⅞"; "B"—1½" to 1⅞" and "C" less than 1½". The "A" size tubers were sorted into U. S. #1 grade and defective tubers. Later random 100-lb. samples of U .S. #1—grade A size tubers were classified over sizing boards into "small—1⅞" to 2½"; "medium"—2½" to 3¼"; and "large"—over 3¼". The percentages of weight of tubers of each of these grades and sizes in each variety treatment was calculated from the total weight sorted. The yields per acre of each were then determined by applying these percentages to the mean total yield determined from field weights. The percentages shown in table 2 were calculated as the percentages that the means of each size or grade class were of the four-year means of total yield—*i.e.*, they are not averages of annual percentages.

Experimental Results

Progress was superior to Triumph in producing greater total yields per acre and greater yields of U. S. #1—grade A size tubers. (Table 2 and Figures 1, 2, and 3). The percentages of U. S. #1-A grade tubers were about the same for both varieties, chiefly because of the smaller size of the Progress tubers. The percentages of "seed size" tubers—*i.e.*, small A size and B and C sizes—were much higher with Progress and the percentages of medium and large A size were lower. Consequently Progress yields of "seed size" were much greater but yields of the most desirable table sizes (medium and large A size) were distinctly lower than those of Triumph. The net yields of potatoes (total less amount of seed planted) were always greater with Progress. The total production per bushel of seed planted was slightly greater with Progress than with Triumph—especially with the lowest planting rate. Progress plants usually emerged a trifle earlier than those of Triumph—but there was little difference in final stands of the plants.

Cut Seed Pieces *vs.* Small Whole Tubers

Small whole Progress seed potatoes were slightly more satisfactory than cut seed pieces of almost equal weight, as shown by slightly greater total and U. S. #1-A size yield. Although there was little difference in the size of the tubers, those from the whole seed were slightly smaller. Plants generally emerged slightly faster and stands were slightly better with small whole tubers than when cut seed pieces were used.

Plant emergence was more rapid and stands of plants were greater with 2-oz. than with 1-oz. seed pieces of both varieties.

With the intermediate planting rate (about 12 bus. per. acre), results from planting small seed pieces close together (Treatment B) differed

TABLE 2.—*Yields and percentages of various grades and sizes of potatoes with four planting distances and seed size combinations on dryland. (Means of 4 years—1948 to 1951.)*

Variety			Triumph				Progress				Progress Whole			
Space in rows			1.16 Ft.		2.32 Ft.		1.16 Ft.		2.32 Ft.		1.16 Ft.		2.32 Ft.	
Weight of seed pieces			2.05 Oz	1.02 Oz	2.05 Oz	1.02 Oz	2.05 Oz	1.02 Oz	2.05 Oz	1.02 Oz	2.05 Oz	1.02 Oz	2.05 Oz	1.02 Oz
Treatment designation			A	B	C	D	A	B	C	D	A	B	C	D
Amount planted per acre (Bus.)			23.44	11.76	11.72	5.88	23.54	11.90	11.67	5.95	23.28	12.68	11.94	6.42
Stand of plants (Per cent)			93.7	88.7	96.2	91.1	92.9	89.2	97.1	92.5	92.7	92.7	96.7	96.9
			Bushels per Acre											
Total yield			200.0	176.1	173.5	138.0	204.8	184.5	172.9	146.8	208.9	202.1	183.5	159.8
"A" Size Above 1⅞ in.	U. S. No. 1 Grade	All No. 1	109.8	107.0	105.6	89.5	114.0	111.2	107.3	92.7	114.3	116.1	112.6	101.4
		Large	.6	3.0	1.1	.7	1.3	0	0.3	1.4	0	.2	1.4	.6
		Medium	38.2	43.5	43.6	37.7	22.5	22.2	28.1	28.7	27.0	26.9	38.6	32.9
		Small	71.0	60.5	60.9	51.1	91.2	89.0	78.9	62.6	87.3	89.0	72.6	67.9
	Defective		50.7	44.6	46.8	35.2	29.6	27.5	28.4	26.1	33.4	30.7	32.3	24.7
	Total A size		160.5	151.6	152.4	124.7	143.6	138.7	135.7	118.8	147.7	146.8	144.9	126.1
"B" size, 1½-1⅞ in.			35.3	22.1	19.0	12.1	54.4	41.4	33.4	25.3	54.3	49.4	34.3	30.1
"C" size, below 1½ in.			4.2	2.3	2.1	1.2	6.8	4.4	3.8	2.7	6.9	5.9	4.3	3.6
U. S. No. 1-small + B size			106.3	82.6	79.9	63.2	145.6	130.4	112.3	87.9	141.6	138.4	106.9	98.0
All U. S. No. 1 + B size			145.1	129.1	124.6	101.6	168.4	152.6	140.7	118.0	168.6	161.5	146.9	131.5
Net: (U.S. No. 1 +B) less Seed planted			121.7	117.3	112.9	95.7	144.9	140.7	129.0	112.1	145.3	148.8	135.0	135.1
Total bu. harv. per bu. planted			8.5	15.0	14.8	23.5	3.7	15.5	14.8	24.7	9.0	15.9	15.4	24.9
			Percentages of Total Yield											
"A" Size Above 1⅞ in.	U. S. No. 1 Grade	All No. 1	54.9	60.8	60.9	64.8	55.7	60.3	62.1	63.1	54.7	57.4	61.4	63.4
		Large	0.3	1.7	0.7	0.5	.1	0	.2	1.0	0	.1	.8	.3
		Medium	19.1	24.8	25.1	27.3	11.0	12.0	16.2	19.6	12.9	13.3	21.0	20.6
		Small	35.5	34.3	35.1	37.0	44.6	48.3	45.7	42.5	41.8	44.0	39.6	42.5
	Defective		25.3	25.3	27.0	25.5	14.4	14.9	16.4	17.8	16.0	15.2	17.6	15.5
	Total		80.7	86.1	87.9	90.3	70.1	75.2	78.5	80.9	70.7	72.6	79.0	78.9
"B" size, 1½-1⅞ in.			17.7	12.6	10.9	8.8	26.6	22.4	19.3	17.2	26.0	24.4	18.7	18.8
"C" size, below 1½ in.			2.1	1.3	1.2	0.9	3.3	2.4	2.2	1.8	3.3	2.9	2.3	2.3
U. S. No. 1-small + B size			53.2	46.9	46.0	45.8	71.2	70.7	65.0	59.7	67.8	68.4	58.3	61.3
All U. S. No. 1 + B size			72.6	83.4	71.8	73.5	82.3	82.7	81.4	80.3	80.7	81.8	80.1	82.2

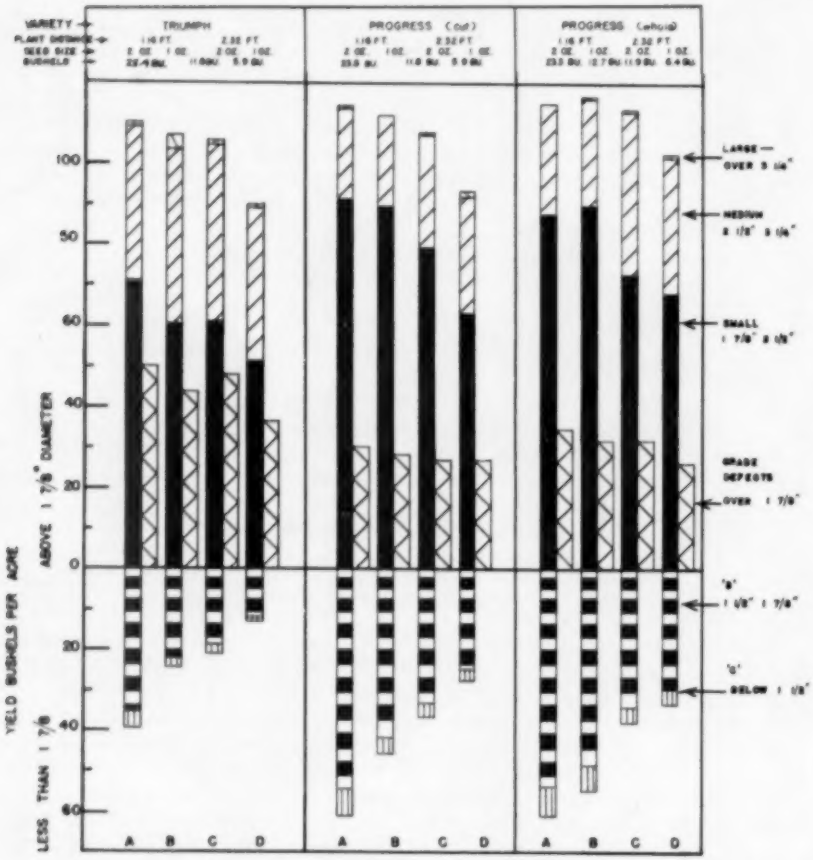

FIGURE 1.—Four-year mean number of bushels per acre of each grade or size with two varieties planted with both seed piece sizes at both planting distances.

from planting seed pieces of double the size at twice the distance (Treatment C) in the following manner:

1. Total yields were greater, especially with whole Progress seed tubers. (With Triumph there was little difference).
2. Yields of U. S. #1-A size tubers were slightly greater.
3. Percentages of U. S. #1-A-size potatoes were slightly lower, the greatest difference having been with Progress whole seed, with practically no difference with Triumph.
4. Percentages and yields of medium-A-size tubers were lower. With Triumph the difference was very small, but with whole tubers of Progress variety it was relatively large.
5. With Progress, percentages and yields of small-A-size tubers were considerably greater, but with Triumph there was little difference.

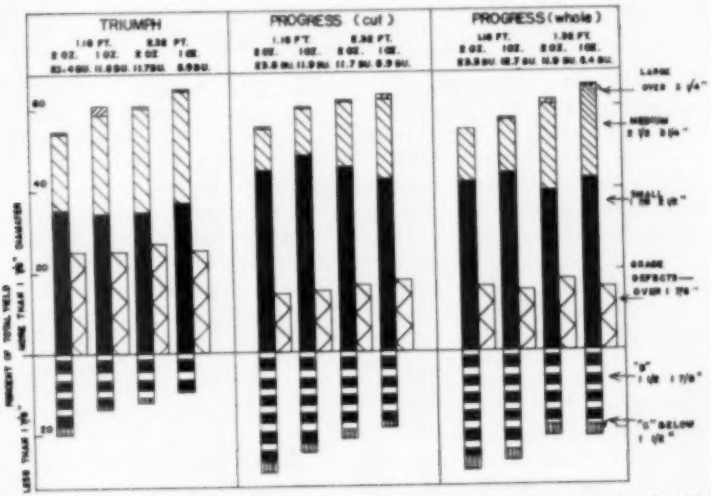

FIGURE 2.—Per cent of 4-year mean total yields of each size or grade classification with two varieties and with both seed piece sizes at both planting distances.

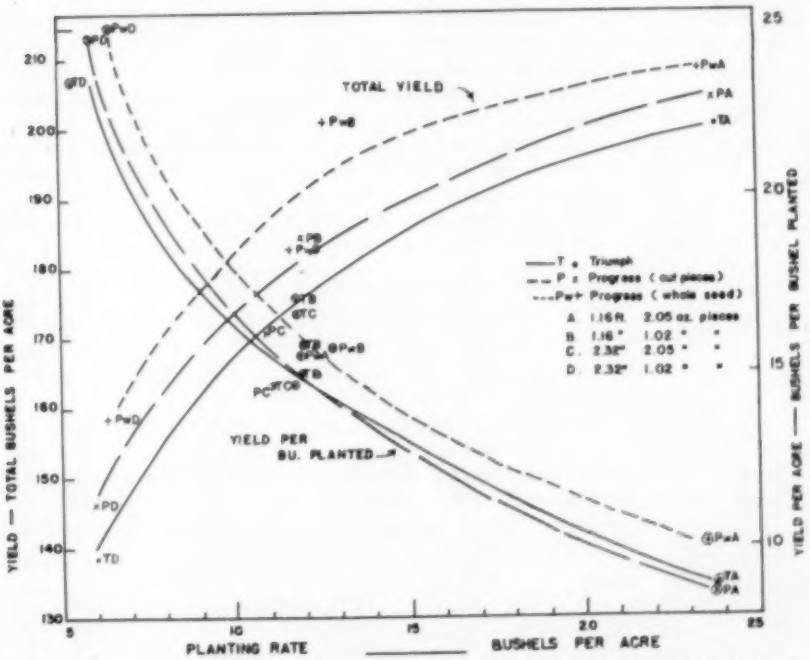
TOTAL YIELD
YIELD PER BU. PLANTED
T = Triumph
P = Progress (cut pieces)
Pw = Progress (whole seed)
A 1.16 ft. 2.05 oz. pieces
B 1.16 " 1.02 " "
C 2.32" 2.05 " "
D 2.32" 1.02 " "
YIELD — TOTAL BUSHELS PER ACRE
YIELD PER ACRE — BUSHELS PER BUSHEL PLANTED
PLANTING RATE
BUSHELS PER ACRE

FIGURE 3.—Graphs of mean total yield per acre (scale at left) and per bushel (scale at right) of two varieties planted with both seed piece sizes at both distances.

6. Greater production and greater percentages of B and C-size tubers —with greatest differences again occurring with whole Progress seed and least with Triumph.
7. Lower percentages of defective tubers of A-size—chiefly because there were fewer tubers with growth cracks, knobs, or poor type.
8. Greater yields of potatoes merchantable for seed purposes (small A-size plus B-size), with differences again being much greater with whole Progress seed and least with Triumph.
9. Greater yields of prime merchantable potatoes (all of U. S. #1-A-size plus B-size) with the differences being greater with both groups of Progress than with Triumph.
10. Greater net yields (bushels planted subtracted from total yield), especially with Progress.
11. Very slightly greater total yield per bushel of seed planted.

With the smallest planting rate (Treatment D), results differed from the intermediate rate (Treatments B and C) as follows:

1. Total yields were much lower.
2. Yields of all grades and sizes of tubers were lower, except that with Progress cut seed pieces the yields of medium and large A-size tubers averaged slightly greater. These differences in yield were usually greatest with Triumph and least with whole Progress seed.
3. Tubers were larger as shown by higher percentages of large and medium A-size tubers and lower percentages of B and C-sizes. With Progress whole seed there was little difference in the percentages of medium and large tubers. With Progress cut pieces the percentages of small A-size tubers was lower, but with whole Progress seed and with Triumph the percentage was slightly greater.
4. Yields harvested per bushel planted were much greater. Because of this, such small planting rates are the most desirable when endeavoring to increase, rapidly, valuable lines of seed or seed stocks of new varieties.

With the *greatest rate of planting* (Treatment A, about 23.5 bus. per acre, large seed pieces planted close) results differed from those with the intermediate rate (Treatments B and C) as follows:

1. Total yields were greater. This difference was least with whole Progress seed and greatest with Triumph.
2. Yields of U. S. #1 grade A-size were slightly greater with cut seed pieces of Triumph and Progress. With whole Progress seed tubers, yields were midway between those of the two methods of planting at an intermediate rate.
3. Percentages of U. S. #1 A-size tubers were always lower.
4. Tubers were smaller as shown by lower percentages of medium A-size tubers, higher percentages of small A-size (except with Triumph where the percentage was slightly greater) and higher percentages of B and C-sizes.
5. Yields of small A-size tubers were greater when cut pieces were used and those of B-size tubers were much greater.

6. Greater yields of seed size tubers and total merchantable tubers, *i.e.*, U. S. #1 A-size. These differences were greatest with Triumph, and less with whole Progress seed.
7. Usually greater net yield of merchantable potatoes.
8. Much lower yield of bushels of potatoes harvested for each bushel planted

Heavy planting rates—such as in this treatment A—can be depended upon to consistently produce greatest total yields, and greatest yields of merchantable and seed size tubers. The yield of U. S. #1 A-size tubers will generally be greater than with half the planting rate and the tubers will be smaller. The increase in yield is much less per bushel of seed planted than occurs between the lightest and intermediate rates. It is apparent that this rate may be preferable to an intermediate planting rate only when seed potatoes are very cheap or when high yields of small ("seed-size") potatoes are the most important consideration. This heavy planting rate has generally been most advantageous in seasons of adequate rainfall that were favorable for high yields, and of least or no advantage in dry years. It has also been more beneficial with Triumph than with Progress. It was of less value when using whole seed tubers than when using cut seed pieces with Progress. It is the most inefficient way to increase valuable seed stocks.

In years favorable for high yields due to well distributed summer rainfall there was more advantage in using the heavier planting rates than in dry years. With intermediate rates of planting the use of large seed pieces far apart was most satisfactory in dry years, but the use of small pieces close together was the best practice in years of more than average summer moisture.

During three years (1947-1949) White Cloud—a relatively minor variety was included. The results with it were similar to those with Triumph. It apparently responded more favorably to the use of large quantities of seed per acre. With the intermediate planting rates, large pieces far apart were usually more desirable than small pieces planted close. Very light planting rates were much less satisfactory with White Cloud than with the two other varieties. The relative weakness or dormancy of basal eyes of White Cloud tubers was chiefly responsible for the poorer stands with that variety and its relatively greater response to the use of large seed pieces.

Summary

1. Three varieties of potatoes were grown on dryland in Western Nebraska for 3 and 7 years with three planting rates using combinations of two seed piece sizes at two planting distances.
2. An intermediate planting rate (approximately 12 bushels per acre) appeared the most practical because of the highest yields, especially the highest net yields of marketable potatoes. This appears to be the most practical rate for most dryland production.
3. With the intermediate planting rate, close planting of small seed pieces was much more desirable than twice the distance with seed pieces weighing twice as much.

4. With planting rates of 23.5 bushels per acre total yields were only slightly greater than with the intermediate rate attained by close planting of small seed pieces, but tubers were usually smaller.
5. The heaviest planting rate (23.5 bushels per acre) was found to be desirable for producing greatest total yields and greatest yields of seed-size potatoes (U. S. #1-small and B size tubers), but least efficient in production per bushel of seed planted. Increased returns for the additional bushels planted (beyond those required for the intermediate rate) were relatively small, indicating that the heavy rates are not likely to be economical except when seed potatoes are very cheap.
6. The lowest planting rate (approximately 6 bushels per acre) produced the greatest yield per bushel of seed planted and the largest tubers, but yields per acre were too low to merit consideration of this rate except when very high-priced seed potatoes or stocks of new or superior strains or varieties are to be increased as rapidly as possible.

POTATO TISSUE CULTURES[1]

H. W. CHAPMAN[2]

Tissue culture techniques provide obvious advantages for investigating the responses of the potato plant to nutrition and other environmental conditions. Although Magrou (4) grew potato seedlings under aseptic conditions in Knop's solution for studies of tuberization; no practical method of tissue culture was reported in the literature until Barker (1) and Barker and Page (2) described the growth of nodes from sterilized potato sprouts *in vitro*.

Haynes (3) recently reported growth of excised potato embryos *in vitro*. However, since plants grown from seed are genetically heterogeneous, a vegetative method of establishing cultures was considered more desirable for the studies reported here. The objective of these studies was to develop a method of growing potato tissues *in vitro* to study tuberization.

MATERIALS AND METHODS

The basic medium used was that formulated by White (8) for culture of plant tissues. Sucrose (2 per cent) and agar (0.7 per cent) were added for most of the experiments. Other modifications are indicated in the discussion. The media were autoclaved for twenty minutes at fifteen pounds steam pressure.

Tissues were rendered aseptic by soaking for 20 to 30 minutes in a 12 per cent by volume Purex (5.25 per cent sodium hypochlorite) solution to which a wetting agent was added. Sprouts were then held under the flap of a sterile towel until the nodes were excised with a scalpel and placed on the media. Erlenmeyer flasks (125 ml.), one ounce, two ounce, and eight ounce screw-cap bottles were used as containers for cultures.

The following plant parts have been used to establish cultures: (1) root tips, (2) tuber parenchyma, (3) excised embryos, (4) tuber eyes, and (5) sprout nodes. Tissues from the Triumph variety have been cultured most extensively, and results reported were obtained from this variety. Sprout nodes of Progress, Irish Cobbler, Golden, Katahdin, and Red Warba varieties have also been cultured successfully.

RESULTS AND DISCUSSION

Culture of Root Tips. Repeated attempts to obtain elongation of root tips have failed. Liquid media as well as those solidified with agar were used. Supplementing the media with coconut milk or yeast extract also failed to stimulate elongation, but the root tips appeared to remain alive even for several months. Cells at the cut surface or cells that were sloughed off, occasionally proliferated, forming undifferentiated growths. These grew readily when transferred to the coconut milk, 2,4-D media described below forming an undifferentiated callus.

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Growth of Undifferentiated Callus. Parenchyma tissue removed from tubers was grown on White's medium supplemented with fresh coconut milk and 2,4-D. A concentration of cocount milk 10 per cent by volume and 7 mg/l of 2,4-D gave the largest callus growth. This result was similar to that reported by Steward and Caplin (6). These callus cultures never differentiated organized tissues. Neither did the addition of adenine sulfate (20, 40, and 60 mg/l) to the medium result in bud differentiation such as that reported with tobacco by other workers (5).

Vegetative Development of Eyes and Sprout Nodes. Entire eyes and individual buds from eyes of mature tubers grown in the greenhouse in solution culture were rendered aseptic and transplanted to nutrient media. These tissues grew, even when removed from tubers which were presumably still in their rest period. It was also noted that aseptic tubers 1/16 to ⅛ inches in diameter formed in culture apparently have no rest period when transplanted to fresh media.

Nodes from potato sprouts were used most extensively as transplants for starting cultures. In most cases root development from the nodes was observed within thirty-six hours following transfer; stem growth followed in approximately four days. In two to three weeks roots were well branched and often extended several times around the base of the container. Root epidermal or cortical cells, probably dislodged by growth of branch roots, frequently proliferated causing white masses of undifferentiated cells. Stems and stolons were much branched and roots frequently developed at nodes well above the media. The leaves were rudimentary and simple even in a light intensity of approximately 1000 f.c.

Tuberization. In the first experiments, cultures were held in diffuse light at room temperature (75-85° F.). After 12 weeks less than 10 per cent of the cultures had tuberized. Recent experiments suggest that heavy tuberization will occur after a period (4-5 weeks) of vegetative development in light at a temperature of 70-80° F. followed by complete darkness for several days at 60° F. The majority of the cultures (up to 90 per cent) tuberized when treated in this manner. In contrast, Barker (1) reported ⅓ of his cultures tuberized within three weeks at room temperature. To this date we have been unable to duplicate Barker's results on tuberization. Sprout nodes, grown on White's medium with the nitrate replaced by chloride ion, tuberized at the same rate as the controls. Werner's (7) conclusion that low nitrogen supply increases tuberization was not substantiated in this study.

Effect of 2,4-D and IAA. A proliferation of cells near the cambial region of sprout nodes resulted when 5 and 10 mg/l of indoleacetic acid were added to the media. A circular mass of tissue formed which was several times the diameter of the original transplant. Although primordial roots frequently differentiated from this tissue, no stem or stolon growth was observed. Reddish purple pigmentation, presumably anthocyanins, was observed in cultures held at 70° F. or below. Active cell proliferation but no organized growth of tissues or organs was noted when 5 and 10 mg/l of 2,4-D were added to the media.

Carbohydrate Nutrition of Sprout Nodes. Sucrose, glucose, and fructose from 0 to 24 per cent by weight were used as sources of carbohydrate for nodal cultures. From 12 to 18 cultures were grown at each concentration of each sugar. Samples of the original transplants

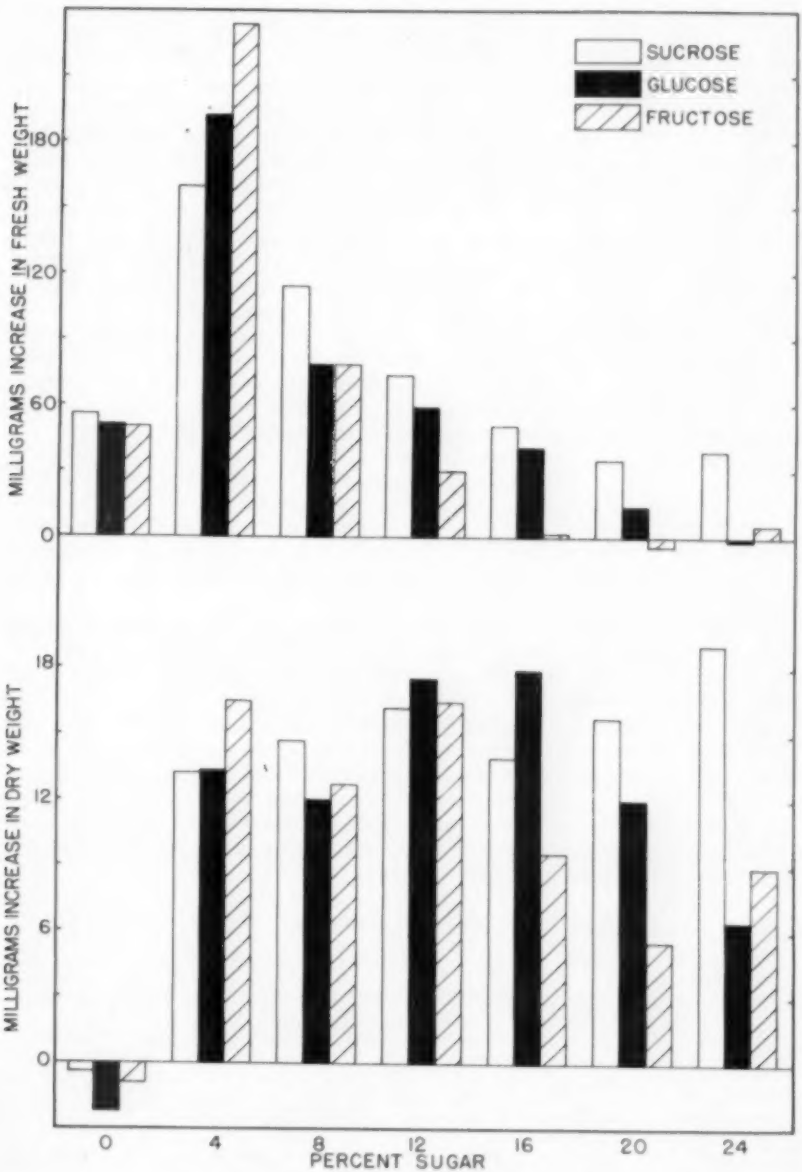

FIGURE 1.—Increase in mean fresh weight and dry weight of tissues per culture bottle following three weeks growth at 60° F.

were selected at random, weighed fresh and then dried for 24 hours at 100° C. when their weight was again recorded. Mean initial fresh and dry weights were 53 mgs. and 8 mgs. respectively. Following three weeks growth at 60° F., increase in fresh weight was largest at the 4 per cent concentration with all sugars (Figure 1). The increase of fresh weight was greater with sucrose at concentrations above 4 per cent than with glucose or fructose. Root growth and usually stem growth were visible at all sucrose levels, but no growth was observed at the highest glucose concentration or when 16, 20, and 24 per cent fructose was incorporated with the media. This presumably was the result of the lower osmotic concentration with sucrose. (Approximately ½ as many molecules of sucrose was added to give 24 per cent by weight in the media as are present in the same per cent of glucose and fructose.) Although the fresh weight and vegetative growth of cultures were greater at the lower sugar concentrations, dry weights were similar at all sugar levels. Some vegetative growth occurred with the sugarless media but dry weights were less than the original transplants. Excellent growth of cultures was also observed with 2 per cent sucrose incorporated in the media.

Summary

Nodes excised from potato sprouts and rendered aseptic with hypochlorite developed to morphologically complete plants in one ounce bottles. White's medium with 0.7 per cent agar added was an excellent growth medium.

Undifferentiated masses of tissue grew readily on the basal medium plus 10 per cent coconut milk and 7 mg/1 2,4-D. Root tips remained alive for some time but did not elongate when supplied with any of several different media.

Tuberization was most rapid when cultures were held in the light for four weeks at room temperature followed by several days in darkness at 60° F. Varying the N level of the medium exhibited no effect on rate of tuberization.

Nodes grew equally well with glucose, sucrose, or fructose as a carbohydrate supply. From 2 to 4 per cent sugar in the media appeared to be near the optimum concentration.

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EFFECT OF INTENSITY, AND WIDTH OF INTER-ROW TILLAGE ON THE YIELD OF THE POTATO CROP[1]

M. A. MOURSI[2]

INTRODUCTION

Inter-row tillage is a well established agricultural practice and there is general agreement between scientist and practitioners about its importance in crop production.

Inter-row tillage has two effects, first it kills weeds growing between the rows; and secondly, it results in a dust mulch. Dust mulch was believed to help in conserving soil moisture, in fact, it is considered to do so by many farmers although field experiments failed to show that this mulch normally has this effect as Periera stated.

REVIEW OF LITERATURE

Russell (1949) showed that the effect of the inter-row tillage on the yield of potatoes was slightly harmful. Keen (1938) stated that extra cultivation of root crops resulted in depressing the yield. Russell and Keen (1938) stated that extra cultivation results in decreasing yield as it causes damage to the surface feeding roots and to the leaves.

MATERIALS AND METHODS

A comprehensive set of experiments was conducted in 1951 and 1952 at Edinburgh University Agricultural Experiment Farm at Roslin, ten miles from Edinburgh. The combination of the intensity and width of inter-row tillage beside some other factors were studied.

There were two intensities of inter-row tillage: two times and three times. There were also two widths of inter-row tillage: narrow inter-row tillage where tines were 8 inches from the plants and wide inter-row tillage where the tines were 6 inches from the plants.

An uncultivated treatment was also included to compare it with the cultivated treatment. Weeds of the different treatments were hand-pulled after inter-row tillage. The randomized block system was used in this experiment.

Kerr's Pink variety was planted in 1951, and the Red Skin variety in 1952.

RESULTS AND DISCUSSION

Effect of Dust Mulch on the Yield of the Potato Crop.

In this study soil mulch did not benefit the crop; on the contrary, the harmful effect of inter-row tillage of destroying the surface feeding roots outweighed its beneficial effect. This holds true in the case of Kerr's Pink as shown in table 1. Under narrow inter-row tillage, where not much harm was done to the roots of Kerr's Pink, there was no difference between this treatment and hand-weeded treatment as shown in table 2.

[1]Accepted for publication December 23, 1954.
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TABLE 1.—*Effect of dust mulch on yield of the potato crop.*

Treatment	Kerr's Pink 1951 Tons per Acre	Red Skin 1952 Tons per Acre
Uncultivated	16.203	17.56
Cultivated	15.408	16.63
L. S. D.	.39	.1.98

TABLE 2.—*The comparison of uncultivation with the narrow inter-row tillage.*

Treatment	Kerr's Pink Tons per Acre
Uncultivation	16.203
Narrow Inter-row Tillage	15.725
L. S. D.	.87

There was no significant difference between inter-row tillage and the uncultivated treatment in the case of Red Skin 1952 (Table 1), because little harm was done to the roots, the lateral spread being much less in Red Skin than in Kerr's Pink.

Inter-row tillage has the advantage of killing the weeds and of helping in the formation of dust mulch. Its only disadvantage is its harmful effect on the root system.

There is no doubt that the killing of weeds should give us a better yield as all weeds share the food,, particularly the nitrogen and the moisture, with the crop. Their competition does not seem to be for moisture as much as for other nutrients, at least under Scottish environmental conditions. So it is apparent that the major injury to the crops results from the weed competition for nitrogen.

The formation of dust mulch does not seem to be a credit to the inter-row tillage, despite the erroneous belief of the farmers that it holds the moisture in the soil. (Lombard 2, Moore 3, Russell 5,6, Keen 1, Periera 4.)

Nevertheless, if only for its weed killing effect, inter-row tillage is beneficially practiced by farmers. Furthermore, it helps the soil to give a better yield of the succeeding crop in the rotation. It has also the advantage of economizing harvesting work and time spent on spraying. So long as ridging is the basis of potato culture, inter-row tillage will be found to be the easiest way of obtaining the tilth needed for ridging.

Effect of Intensity of Inter-row Tillage on Yield.

In the present study it was found that the yield does not increase if the number of inter-row tillage is increased from two to three (Table 3): the reason being that inter-row tillage destroys a considerable proportion

TABLE 3.—*The effect of intensity of inter-row tillage on yield.*

Treatment	Kerr's Pink 1951 Tons per Acre	Red Skin 1952 Tons per Acre
Two times of inter-row tillage	15.186	16.75
Three times of inter-row tillage	15.624	16.73
L. S. D.	.501	1.91

of the roots as well as some leaves. It is apparent that there is no point in going beyond a certain number of inter-row tillages, because the yield usually decreases rather than increases by increasing the frequency of inter-row tillage. This was observed also by Keen (1), Russell (5), and Russell and Keen (6) who found that intensive cultivation of the root crops results in depressing the yield. This conclusion need not lead to the cessation of inter-row tillage. In this connection the following questions merit careful consideration before these extra inter-row tillages can be profitably omitted. Will the subsequent crops in the rotation benefit by these operations? The answer depends on weed population. Again, it should be emphasized that inter-row tillage is done with the object of weed destruction. Any work in excess of weed destruction is unproductive. If the potato is a clean crop in the rotation, then certain perennial weeds may be best killed by frequent grubbings, and this should pay and benefit the succeeding crop in the rotation. How far is the labor of extra cultivation offset by a saving time in harvesting potatoes? On light soils very slight ridging will be adequate if a lifting plow or other suitable implement is used for harvesting. The belief that the crop will gain by high ridging should be combatted. The only effect on the crop will probably be extra root-pruning and the grower will find himself committed to deeper initial grubbing at an additional cost.

The Effect of Width of Inter-row Tillage.

Apparently the effect of the inter-row tillage depends on the lateral extent of the roots and that, in turn, varies with the variety of the plant, so that where a particular variety may respond to more than one width of inter-row tillage, another variety might show a better effect with one definite width of cultivation. It was stated that the Red Skin variety gives similar yield when inter-row tillage is used at a width of 6 and 8 inches from the plant. The Kerr's Pink was more affected when cultivated at a width of 6 than when cultivated at 8 inches. Kerr's Pink (Table 4) gave less yield in the first case where the tines were nearer to the plants. This may be explained by the fact that the extent of the roots of Kerr's Pink was greater than those of Red Skin.

From this study it is recommended that the close inter-row tillage, approximately 6 inches from the plant in the earlier stages of development; and wide inter-row tillage, say 8 inches from the plant should be used, when the plants advance in growth. This would facilitate hand-hoeing at the earlier stages of growth (as the part left to be hoed will be narrow) without any serious interference with the roots, and compel us to use narrower cultivation later on to ensure their intactness.

TABLE 4.—*The effect of width of inter-row tillage on the potato yield.*

Treatment	Kerr's Pink 1951 Tons per Acre	Red Skin 1952 Tons per Acre
Wide Inter-row Tillage (6 inches from the Plant)	15.08	16.41
Narrow Inter-row Tillage (8 inches from the Plant)	15.81	16.86
L. S. D.	.495	1.91

SUMMARY

This work was designed to study the effect of the intensity and width of inter-row tillage on the yield of the potato crop.

Soil mulch appeared to have no effect on yield.

Inter-row tillage benefited the crop although it restricted the growth of weeds only, and did not create soil mulch.

It is not of any value to potato yields to carry on with cultivation more than twice.

Narrow inter-row tillage (tines 8 inches from the plant) benefited the yield more than wide inter-row tillage (tines 6 inches from the plant). This held true in Kerr's Pink, although it does not apply in the case of the Red Skin variety, because the lateral spread of the root system is greater in the case of Kerr's Pink.

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REACTIONS OF POTATO VARIETIES TO LATE BLIGHT AND INSECT INJURY AS REFLECTED IN YIELDS AND PERCENTAGE SOLIDS[1]

F. J. STEVENSON, R. V. AKELEY AND R. E. WEBB[2]

Diseases and insects continue to take a toll from the potato crop in Maine in spite of the efforts and expense that are spent annually in attempts to control them. Late blight is still the most destructive disease, and aphids and flea beetles are the most destructivee insects. The destruction depends on the season, thoroughness of control measures, and the varieties of potato grown. Some seasons, like that of 1953, are not favorable for late blight, and susceptible varieties could be grown without the application of fungicides. During other seasons late blight is prevalent, but weather conditions permit the regular application of fungicides, and little damage results. However, all too often, seasons similar to that of 1954 occur when conditions are favorable for the development of late blight, because rainy weather throughout the summer interferes with the application of fungicides at the proper time, and the fungicides that are applied are soon washed off. Under such conditions late blight develops rapidly, the vines of all susceptible varieties are killed early, yields and percentage solids are reduced, and much rot is found in the tubers, all of which result in losses not only in the growing crop but also in the stored crop. In seasons of this nature the value of blight-resistant varieties is emphasized.

For a number of years tests have been conducted to determine the performance of susceptible and resistant varieties of potato when grown with different applications of fungicides and insecticides. The results for the non-blight season of 1953 and the bad-blight year of 1954 will be discussed in this paper.

MATERIALS AND METHODS

Each year two blight-susceptible varieties, Green Mountain and Katahdin, and four blight-resistant varieties were included in the tests. In 1953 the four resistant varieties were Sebago, Cherokee, Pungo, and Kennebec; and 1954, Delus, Kennebec, Merrimack, and Saco.

The design of the experiment was a split-block 4 x 4 latin square. Each sub-plot consisted of 30 hills planted 10 inches apart in the row, and the rows were 34 inches apart. Four sprays were applied: water, DDT, basic copper, and basic copper + DDT. In 1953 Parathion was added to two of the DDT sprays and in 1954 to one. Teton, a blight-susceptible variety, was planted throughout the plot. Three rows of the varieties under test were followed by two rows of Teton. The Teton served three purposes: It prevented spray drift, wheel injury, and in a year favorable for late blight an epidemic quickly developed on this unsprayed variety from which it spread to other varieties.

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The inoculum was provided by placing potted plants of Green Mountain heavily infected with the 0 race of the Late blight fungus between the paired rows of Teton as near as possible to the center of the plot. Inoculations were made in mid-July of both years. In 1953, two additional inoculations were made with little success. Sprays were applied at 7-day intervals throughout the growing season, regardless of the weather.

In 1954 records showing the progress of the disease were taken on three different dates: August 13, August 20, and September 4.

Results

Because the 1953 season was unfavorable for the development of late blight, the disease did not spread effectively from the inoculated plants of Green Mountain to those of Teton or any of the other varieties. Temperature and moisture conditions were such that all varieties were free from blight throughout the growing season. On the contrary, in 1954, frequent rains occurred, and a heavy epidemic of late blight was soon prevalent on Teton plants, which were not sprayed, and on the non-sprayed susceptible varieties. Because of the rains the basic copper sprays were not so effective as they should have been, and eventually all plants in the test became blighted; but the blight-resistant varieties were the last to go down.

The data for the 1953 season are given in table 1. Since there was no injury from late blight and not much insect injury, satisfactory yields were obtained from all varieties. The plots of the six varieties sprayed with insecticides alone ranked first in yield. The plots sprayed with water yielded on the average higher than the corresponding plots sprayed with basic copper and almost as much as those sprayed with basic copper + DDT + Parathion. It would appear that the basic copper had a tendency to suppress yields in all varieties tested. Kennebec ranked first in yield in all comparisons except in the plots sprayed with basic copper where it was outyielded by Green Mountain. On the average for all four treatments Kennebec outyielded the other five varieties significantly.

The percentage solids was relatively high for all varieties in all treatments. The plots sprayed with DDT + Parathion were significantly lower statistically than corresponding plots given the other treatments, but such small differences would probably not be apparent in any cooking test.

In the non-blight year, 1953, all varieties produced satisfactory yields regardless of the spray used, but in the bad blight year, 1954, the outcome was quite different. Because the conditions were very favorable for the spread of blight a heavy epidemic soon developed on the unsprayed Teton and the susceptible Green Mountain and on Katahdin plants sprayed with water or DDT alone when inoculm was placed in the plots about mid-July. The resistant varieties Delus, Kennebec, Merrimack, and Saco became infected with blight during the latter part of the growing season. However, the disease did not do much damage before the varieties had produced a good crop of potatoes with a relatively high dry-matter content. There is every reason to believe that the specialized races of the fungus caused the infection on these varieties. Isolates of the late blight

TABLE 1.—*Reactions of six varieties of potato to various sprays for the control of late blight and insect injury as reflected in yields*[1] *and percentage solids*[2], *Aroostook Farm, Presque Isle, Maine, 1953.*

Variety	Water			DDT + Parathion			Basic Copper			Basic Copper + DDT + Parathion			Means		
	U.S. No. 1		Solids	U.S. No. 1		Solids	U.S. No. 1		Solids	U.S. No. 1		Solids	U.S. No. 1		Solids
	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent
Green Mountain	541	96	21.4	622	97	21.0	550	95	21.9	535	96	21.1	562	96	21.4
Katahdin	446	91	20.3	530	94	19.2	416	90	19.9	498	93	19.9	472	92	19.8
Sebago	514	93	19.9	547	95	19.2	448	91	19.9	489	93	19.6	500	93	19.7
Cherokee	455	94	20.3	486	93	19.4	414	91	20.4	458	93	20.2	453	93	20.1
Pungo	526	97	20.5	581	98	20.2	464	96	20.4	516	98	20.0	522	97	20.3
Kennebec	580	95	20.4	654	97	19.8	511	96	20.2	611	97	20.4	589	96	20.2
L.S.D. (5 Per cent)	48.9		0.7	48.9		0.7	48.9		0.7	48.9		0.7	24.5		0.4

[1]Yields given in bushels per acre of U. S. No. 1 potatoes.
[2]Percentage solids based on the specific gravity of the tubers.

fungus were isolated from plants growing adjacent to the spray test. These were tested on 8 of the differential hosts of the physiological races of the late blight fungus. The tests showed that specialized races 1, 2, 3, and 4 in addition to the common races were present in the field.

The data showing the differences in the time that the plants of the six varieties became seriously diseased are given in table 2. These data were taken on each of the plots at three different dates. Green Mountain and Katahdin sprayed with water or DDT only were almost covered with late blight on August 13 and as a result were nearly dead on that date. The plants in the corresponding plots of the four resistant varieties showed little infection on August 13 and were not heavily infected until September 4, when a small percentage of their foliage was still green. At that time the Green Mountain and Katahdin plants were dead.

Basic copper only partially controlled the disease on the susceptible varieties Green Mountain and Katahdin, as the plants showed about 25 per cent infection on August 13 and were almost covered completely with blight on September 4. In contrast, the plants of Delus, Kennebec, Merrimack, and Saco, sprayed with copper, showed a very low percentage of infection throughout the three weeks in which the records were taken. These differences in time when infection took place explain the large differences between the yields of the susceptible varieties and the resistant varieties. The yield and percentage solids data for the 1954 tests are given in table 3.

In the plots sprayed with water the yields of Green Mountain and Katahdin were 72 and 93 bushels per acre, respectively, but the four blight-resistant varieties yielded more than 400 bushels per acre. Kennebec ranked first with a yield of 567 bushels per acre; and Saco was a close second with 553 .

The plots sprayed with DDT and Parathion with no copper gave results similar to those sprayed with water. Green Mountain yielded the same in the plots sprayed with insecticides alone as it did in the plots sprayed with water: 72 bushels per acre. Katahdin yielded slightly higher in the DDT plots than in the water-sprayed plots. In the plots sprayed with insecticides alone Saco yielded 608, Kennebec 560, Delus 384, and Merrimack 480 bushels per acre, respectively.

Many decayed tubers were found in the Green Mountain and Katahdin plots to which no copper was applied, but none in those of the blight-resistant varieties.

When basic copper alone was sprayed on the plants every seven days, the yields of Green Mountain and Katahdin were 224 and 269 bushels per acre, respectively, as compared with 637 for Saco and 608 for Kennebec. Another look at table 1 reveals that in 1953 Green Mountain yielded almost as much as Kennebec on the average for all four treatments. It is evident then that in 1954 even when sprayed with copper, Green Mountain yielded about 35 per cent of a crop and Katahdin about 60 per cent of what it should have yielded if not injured by blight.

Basic cooper + DDT sprayed on the plants every seven days with Parathion added to one of the sprays gave the highest yields for all six varieties. This would indicate that the insecticides were of value in protecting the plants from injury.

TABLE 2.—*Late blight data taken on 3 dates showing comparative amounts of disease on 6 varieties of potato grown with 4 spray treatments on the Aroostook Farm, Presque Isle, Maine, 1954.*

Sprays	Late Blight Infection Indexes[1]							
	Date	Green Mountain	Katahdin	Delus	Kennebec	Merrimack	Saco	Mean
Water	8/13	9.25	8.75	0.75	0.50	1.00	1.00	3.54
Do	8/20	11.00	11.00	4.50	2.50	3.25	3.25	5.58
Do	9/4	11.00	11.00	10.25	8.50	8.50	9.50	9.79
Mean		10.42	10.25	4.50	3.83	4.25	4.58	6.30[3]
DDT[2]	8/13	9.25	8.75	.50	.50	.50	.75	3.37
Do	8/20	11.00	10.75	3.50	3.00	3.25	3.75	5.87
Do	9/4	11.00	11.00	10.00	8.75	7.25	9.75	9.62
Mean		10.42	10.17	4.67	4.08	3.67	4.75	6.29[3]
Basic Copper	8/13	4.75	4.75	.25	.00	.00	.00	1.54
Do	8/20	9.50	9.50	1.25	1.00	1.00	1.00	3.87
Do	9/4	10.75	10.75	2.00	1.75	2.00	2.00	4.87
Mean		8.33	8.17	1.17	.92	1.00	1.00	3.43[3]
Basic Copper + DDT[2]	8/13	4.00	4.00	.00	.00	.00	.00	1.34
Do	8/20	7.00	7.25	1.00	1.00	1.00	1.00	3.04
Do	9/4	10.00	9.75	2.00	1.25	1.00	2.00	4.33
Mean		7.00	7.00	1.00	.75	.67	1.00	2.90[3]
All Sprays (Mean)		9.04[4]	8.94[4]	3.00[4]	2.40[4]	2.40[4]	2.83[4]	

[1]Indexes: 0 = 0 per cent infection. 1 = 0 to 3 per cent infection. 2 = 3 to 6 per cent infection. 3 = 6 to 12 per cent infection. 4 = 12 to 25 per cent infection. 5 = 25 to 50 per cent infection. 6 = 50 to 75 per cent infection. 7 = 75 to 88 per cent infection. 8 = 88 to 94 per cent infection. 9 = 94 to 97 per cent infection. 10 = 97 to 100 per cent infection. 11 = 100 per cent infection.

[2]Parathion was added to 1 spray.
[3]L.S.D.'s at 1-per cent level; between sprays for all dates .64
[4]L.S.D.'s at 1-per cent level; between varieties for all sprays .72

In 1954 tubers of Green Mountain and Katahdin from plots sprayed with water gave 16.9 and 15.8 per cent solids, respectively. With the same treatment, Delus produced 20.1, Kennebec 19.1, Merrimack 19.7, and Saco 19.0. The tubers from the plots sprayed only with insecticides showed similar comparisons. The tubers of all six varieties from the plots sprayed with basic copper were higher in dry matter than those produced without the application of the fungicide. However, the highest percentages of solids were found in the tubers of five varieties sprayed with copper + the insecticides, ranging from 20.7 to 21.7 per cent. Katahdin was the exception with 17.4 per cent solids, the same as the Katahdin tubers from the plots sprayed with copper alone. It is evident from the data that the

TABLE 3.—*Reactions of six varieties of potato to various sprays for the control of late blight and insect injury as reflected in yields*[1] *and percentage solids*[2], *Aroostook Farm, Presque Isle, Maine, 1954.*

Variety	Sprays, Yield, and Percentage Solids											
	Water			DDT[3]			Basic Copper			Basic Copper + DDT[3]		
	U.S. No. 1		Solids	U.S. No. 1		Solids	U.S. No. 1		Solids	U.S. No. 1		Solids
	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent	Bus.	Per cent	Per cent
Green Mountain	72	35	16.9	72	38	17.4	224	69	20.1	287	73	20.9
Katahdin	93	51	15.8	114	52	15.5	269	80	17.4	271	81	17.4
Delus	414	95	20.1	384	95	19.9	430	96	20.9	448	96	21.7
Kennebec	567	94	19.1	560	94	18.7	608	94	20.5	646	91	20.7
Merrimack	409	92	19.7	480	92	19.9	486	94	21.6	540	94	21.7
Saco	553	88	19.0	608	88	19.0	637	89	21.4	674	90	21.6
L.S.D. at 5-per cent level	60		.8	60		.8	60		.8	60		.8

[1]Yields given in bushels of U. S. No. 1 potatoes.
[2]Percentage solids based on the specific gravity of the tubers.
[3]Parathion was added to one spray.

Green Mountain and Katahdin plants grown in the plots sprayed with water or DDT died before they could produce potatoes with a high percentage of solids.

Discussion and Summary

In recent years the United States Department of Agriculture in cooperation with several State agricultural experiment stations released a number of blight-resistant varieties of potato to growers. Among these are Sebago, Cherokee, Pungo, Kennebec, Delus, Merrimack, and Saco. Sebago is only moderately resistant to late blight, but the other six are highly resistant to, if not immune from, the common race of the late blight fungus. However, in recent years specialized races of the late blight fungus have appeared and attacked these varieties. From this it might be concluded that our work in breeding for blight resistance has been to no avail. Tests in Maine show that the specialized races do attack these varieties, but the infection, up to the present, occurs late in the growing season after the resistant varieties have produced a satisfactory crop of potatoes and at least two weeks after the plants of susceptible varieties are badly injured by the disease. Tests showed also that in a year favorable for late blight but adverse to proper control operations, the disease is much easier to prevent on the resistant varieties than on the susceptible sorts.

In 1953, when no blight developed in the test plots, the resistant varieties tested compared favorably in both yield and dry matter with the two susceptible varieties.

In 1954, a year that will be recorded as a bad blight year in Maine, the four resistant varieties produced relatively high yields and percentage solids without being sprayed with a fungicide, but the susceptible varieties were almost a total failure. Sprayed with basic copper every seven days the resistant varieties yielded somewhat higher than they did without it but the susceptible varieties were still low in yield. The dry-matter content of the tubers of all six varieties produced in the plots sprayed with copper was higher than that of those grown without copper spray.

Results of these tests indicate that it would pay to grow resistant varieties and, in bad blight years, to spray them with a fungicide.

Although good yields and fair dry matter were produced without the application of a fungicide, better results were obtained when the plants were sprayed with copper, demonstrating the fact that genes for resistance and control measures can be co-partners.

A VALUABLE INDICATOR PLANT FOR A STRAIN OF POTATO VIRUS Y[1]

K. SILBERSCHMIDT AND E. ROSTOM[2]

A short time ago Silberschmidt K., Rostom E. and Mattos Ulson C. (8) described necrotic symptoms exhibited by the inoculated and younger leaves of *Nicotiana Tabacum* var., White Burley infected with a virus considered as a strain of potato-virus Y, (here called necrotic-fleck-strain). In the meantime some additional results were obtained which agree with our original supposition. When we, for instance, transmitted our virus by *Myzus persicae*, to plants of *Nicotiana Tabacum* White Burley, which previously had been inoculated with potato-virus X, the plants reacted by stunting and by the formation of extensive necrotic lesions that means by more severe symptoms than those displayed by tobacco plants when inoculated with our virus only.

In the first period of our studies on this necrotic-fleck-strain (n.f.s.), only the necrotic symptoms which it induced in tobacco plants of the variety White Burley permitted us to distinguish it from other strains of potato virus Y. In an attempt to find other independent and objective means of characterizing our strain, we inoculated several potential host species with it.

On leaves of *Nicandra physaloides* (L.) Gaertn. rubbed with sap, containing n.f.s., 7-12 days after the inoculation we observed the appearance of faint necrotic rings. Later the necrotic border of the rings grew broader and acquired a dark-purple color, but still included a green center. Finally some of the lesions maintained their ring-like appearance, others became dark, necrotic disks (Figure 1).

These "local symptoms," (which differ however in some points from the local symptoms described for other viruses) occur only on the inoculated leaves. Young leaves of *Nicandra physaloides*, the older leaves of which had been rubbed with virus-containing sap, display round chlorotic spots, often situated near the secondary veins, about 3 weeks after the inoculation (Figure 2).

The necrotic ring-like lesions, which appear on the leaves of *Nicandra physaloides* inoculated with the n.f.s. of potato-Y-virus, seemed to us of a great interest from two different points of view.

1. The necrotic rings on the inoculated leaves of *Nicandra physaloides* represent differential and distinctive symptoms of our strain (the n.f.s.) of potato-Y-virus.

We performed a total of six series of experiments comparing the symptoms induced on leaves of *Nicandra physaloides* by our strain of potato-Y-virus with those obtained on the leaves of plants of the same species by inoculation with either one of two other strains of the same virus. In one of these six series of experiments the plants of *Nicandra physaloides* were rather old and did not display symptoms, even after inoculation with the n.f.s. of potato-Y-virus. In all the other tests, only our strain of Y-virus induced the necrotic local symptoms on the inoculated leaves of *Nicandra physaloides*, whereas the two remaining strains caused only faint systemic symptoms on the young leaves.

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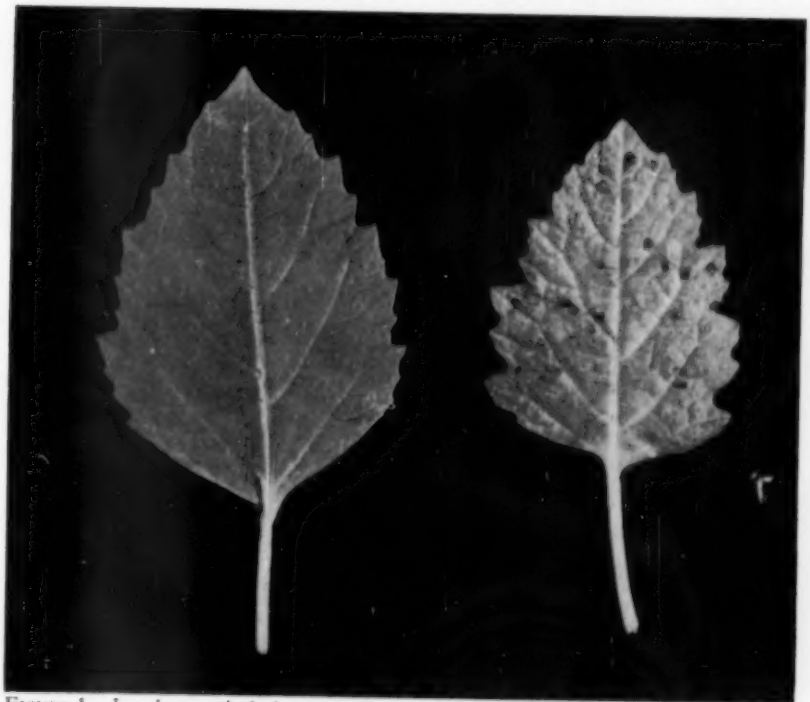

FIGURE 1.—Local necrotic lesions on a leaf of *Nicandra physaloides*, inoculated 8 days before with sap containing our strain of potato virus Y (right), healthy leaf (left).

FIGURE 2.—Systemic symptoms displayed by young leaves of plants of *Nicandra physaloides*, the older leaves of which had been rubbed 23 days before with sap containing the n.f.s. of potato virus Y (left and center), healthy leaf (right).

2. Another reason for deciding to study the necrotic symptoms, described in this paper, in greater detail, is related with the proper character of these "local symptoms."

In other words, we believe, that this type of symptom, which is "local" without being "primary," so far has not been distinguished properly in the literature from the common type of local symptoms.

This common type of local symptoms is characterized by Bawden (1) in the following words: "There are visible local lesions formed at the point of entry of the virus into the plant." Kenneth Smith (9) states that the primary symptoms develop before the virus is generally distributed throughout the plant. According to Spencer and Price (11) the local lesions (caused by tobacco mosaic virus) are noticeable in *Nicotiana glutinosa* on the second or third day following inoculation and are completely formed by the fifth day. At some of these points the local lesions, which we observed on inoculated leaves of plants of *Nicandra physaloides*, differ considerably from the "standard type" of local lesion.

In the first place, in the case of *Nicandra physaloides*, it takes 7-11 days, until the local lesions can be observed. They are especially clear-cut on maturing leaves, in which the yellow leaf-blade forms an efficient background for the dark-purple-rings (Figure 3). To a certain degree, it seems, that the virus content of the leaves tends to hasten the maturing of the leaves. In any case we observed that leaves of *Nicandra physaloides* inoculated with n.f.s. turn yellow much more quickly than comparable leaves of control plants. Probably in consequence of this quicker pathological maturing the inoculated leaves also drop more easily than the control leaves.

On the other hand, despite having performed several tests for this very purpose, we could not establish a reliable relation between the virus concentration of the inoculum and the number of local lesions. This failure is probably, at least in part, due to the considerable variation in the susceptibility to the virus between different plants and even between different leaves of the same plant. The extent of this variation and its disfavorable influence on any attempt of a quantitative evaluation of the number of lesions, can be seen by the figures given in table 1.

Each leaf except the control leaf of the plants, quoted in table 1, had been rubbed either with a concentrated (1/1) or a diluted (1/2) inoculum. The lesions were counted 11 days after the inoculation. The leaves in the table are listed in acropetal order.

Discussion

Smith and Dennis (10) based their description of a suspected variant of *Solanum* virus 2 on the necrotic symptoms induced by this virus in tobacco White Burley. The same plant species was used as a differential host in the studies on strains of potato-virus-Y performed by Nobrega and Silberschmidt (6) and by Silberschmidt, Rostom and Ulson (8). Darby, Larson and Walker (2), in their bulletin, on potato virus Y strains, recommended for differential purposes also the use of *Nicotiana Tabacum* and of several potato varieties. In the same bulletin some experiments are included on the use of *Lycium barbarum* L., *Lycium halimifolium* Mill, *Lycium rhombifolium* (Moench) Dippel, *Physalis turbinata* Medic. and *Physalis floridana* Rydb. as indicator species for strains

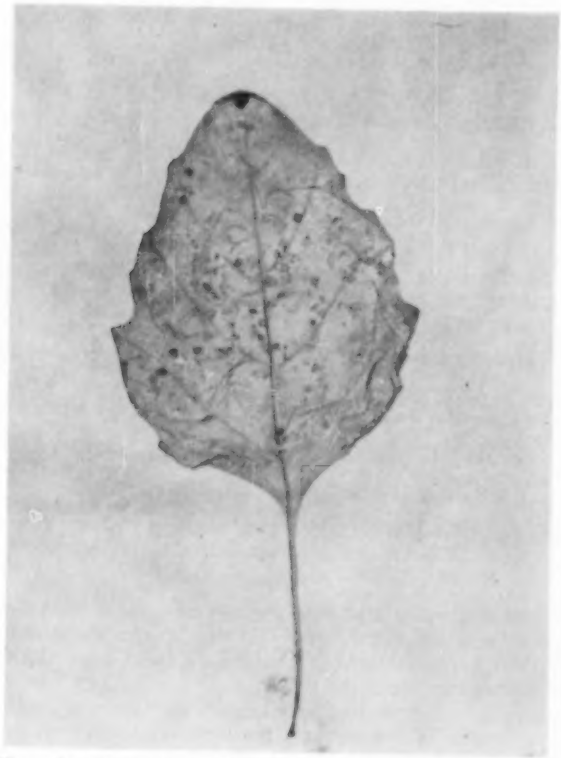

FIGURE 3.—Necrotic rings and disks displayed by a maturing leaf of *Nicandra physaloides*, inoculated 7 days before with sap containing the n.f.s. of potato virus Y.

of the virus Y. They were found to be only of a restricted value for the differentiation of strains of potato-virus Y. Hutton and Peak (3), with good results have made use of *Lycium halimifolium*, *Lycium rhombifolium*, *Physalis floridana* and *Capsicum annuum* for characterizing strains of the potato-virus Y. According to this short review of the literature it seems, that *Nicandra physaloides* previous to our studies, has not been used or at least has not been found valuable as a differential host for strains of the potato-virus Y.

In the literature, scattered over many publications, we find references to symptoms occurring on the inoculated leaves, which, however, must not be mistaken for primary symptoms. We shall mention here only the yellow circular blotches observed by Silberschmidt (7) on the inoculated leaves of *Tropaeolum majus* L. The etiology of these symptoms, which seem to be related in some way with the process of the physiological maturing of the leaves, has so far not been studied exhaustively.

Koehler (4), who gave a very comprehensive description of the formation of necrotic lesions on inoculated leaves, did not include, in his review, the belated local symptoms referred to in this paper.

TABLE 1.—*Number of lesions on the leaves, listed in acropetal order, of Nicandra physaloides.*

Nic. physal. E 2222		*Nic. physal.* E 2223		*Nic. physal.* E 2224
Conc. of Inoculum 1/2		Conc. of Inoculum 1/1		Conc. of Inoculum 1/1
Lateral Branch	Chief Stalk	Lateral Branch	Chief Stalk	Unbranched Stalk
171	51	277	304	44
			Control	
110	97	167	Leaf (0)	54
27	138	80	277	Control Leaf (0)
	14		312	0
	Control			
	Leaf (0)		3	4
	44			0
	8			0
	0			

C. The necrotic spots and rings on the inoculated leaves of *Nicandra physaloides* observed by us are very similar to the symptoms described on the same host species by Mac Lachlan, Larson and Walker (5) as characteristic for potato-virus A.

Since many of our tests clearly show that we are dealing with a strain of potato-virus-Y (short prepatent-period in *Nicotiana Tabacum* White Burley, susceptibility to our virus of *Nicotiana rustica* and *Nicotiana glutinosa* and the occurrence of a synergistic reaction on White Burley tobacco between our virus and potato-virus X), it is important to make sure, in using *Nicandra physaloides* as indicator species, that other viruses, which could cause confusion, be excluded from the tests. This need for precaution has already been stressed by Mac Lachlan, Larson and Walker (5).

SUMMARY

1. Local ringlike-necrotic lesions (Figures 1 and 3), which appear on the inoculated leaves of *Nicandra physaloides*, are shown to be characteristic and differential symptoms of the strain of potato-virus Y, described by Silbershmidt, Rostom and Mattos Ulson (8). The same strain also induces systemic symptoms in *Nicandra physaloides* (Figure 2).

2. In the discussion the several differential hosts of strains of the potato-Y-virus, described in the literature, are reviewed and the special character of the symptoms induced by our strain of potato-virus-Y on the inoculated leaves of *Nicandra physaloides* are pointed out. These symptoms are local without being primary.

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POTATO NEWS AND REVIEWS

CANADIAN INSPECTION PROCEDURE—TABLE POTATOES[1]

P. W. CLEMENT[2]

During the past few years we, in Canada, have realized that potatoes offered to consumers through normal retail channels leave something to be desired. According to press and trade reports the same situation exists here in the U. S. A. and, apparently, it is felt that, aside from competitive and substitute products, the poor quality and grades are having a bad effect on the total consumption of potatoes. We, in Canada, have a similar situation which we are trying to meet by marshalling all the regulatory powers at our disposal. It may be of interest to you, to learn about how we operate and about our authority for doing the things we do. Although my references will be to potatoes the same remarks could apply equally well to numerous other commodities.

The Fruit and Vegetable Division of the Canadian Department of Agriculture performs two main functions with respect to the marketing of fruits and vegetables including potatoes. The first, but by no means the biggest function, is administration of regulatory provisions of the Federal Act. The second and largest function is the operation of a commercial inspection service. It is the administrative or regulatory function that concerns us today but I cannot ignore certain aspects of the commercial inspection service which tie in very closely with our administrative duties. To explain some of our actions with respect to potatoes a brief history of the growth of our service is necessary.

HISTORY OF INSPECTION SERVICE

In the late nineteenth century there was a general development in Canada of inspection services of one kind or another affecting a variety of agricultural products. At the outset, regulations were formed and designed to promote the quality of produce moving to export markets and our efforts in this regard met with considerable success. Beginning in 1920 with the growth of the domestic market there was a general move to apply to the domestic market the same principles that had been applied with such success to the export market. In the original legislation affecting the domestic market the Federal Government assumed the authority for establishing and enforcing grade standards and other regulatory functions, but as time passed and the assumption of the authority was successfully challenged in the Courts, our method of operation was drastically changed. Since 1935, when the present Federal Act was passed, there has developed a system whereby Federal inspectors must act in a dual capacity to enforce the regulatory functions of both Federal and Provincial Acts.

[1]Accepted for publication December 7, 1954.

[2]Associate Chief, Inspection Services, Fruit & Vegetable Div. Canada Department of Agriculture, Ottawa, Canada.

Division of Authority

It is only when produce moves in interprovincial or export trade that the Federal Government can assume any jurisdiction. After the produce is received and offered for sale in a Province it comes within the jurisdiction of the Province in exactly the same way as fruits and vegetables grown and sold within the Province are under Provincial jurisdiction. As a consequence, we have in nearly all Provinces of Canada what we call "concurrent legislation", that is Provincial legistation which is—to all intents and purposes—the same as the Federal legislation. The Provinces appoint the Federal inspectors located within the Province as enforcement officers of the Provincial legislation and as a result we have Federal employees with authority to enforce two sets of regulations—either of which may be used depending on the circumstances .

One part of one section of the Federal legislation is quoted below. It is this section, repeated in similar words in Provincial Acts, that allows us to accomplish our purpose. Section 15(a) of the Federal Regulations reads:—

> "No person shall transport, pack, advertise, display or offer for sale, sell or have in his possession for sale any produce which has not been graded and inspected and, if in packages, packed and marked in accordance with the provisions of this Act and the regulations . . . . ."

This section forms the basis of our administrative or regulatory work and when combined with the various grade, and package and marketing regulations, covers most all aspects of marketing so far as quality standards are concerned.

Inspection and Certification Service

The administrative or regulatory function is supplemented by a commercial inspection and certification service that has developed since 1925. At the outset inspection and certification was purely voluntary but, as the years passed by, various compulsory inspection features were included in the regulations. This was not an arbitrary move on the part of the Federal Government but was done at the request of various Provincial Governments expressing the wishes of producers within any specified Province. As a result, we have compulsory inspection and certification on potatoes moving from the principal producing areas out of the Province where grown. In addition, all potatoes moving out of Canada are inspected and certified to a definite grade standard.

If inspection, compulsory or otherwise, reveals that the potatoes fail to meet the minimum grade or the grade declared they simply are not permitted to move from the Province and an inspector can take steps under Provincial authority to prevent the shipment or sale inside the Province. No provision is made for percentage grades.

We have now arrived at this situation:—

1. Under Federal regulatory measures no potatoes can move from Canada or from one Province to another unless they are properly graded to at least a specific minimum standard and packaged and marked in accordance with established regulations;

2. Potatoes grown in the principal producing areas must be Government-inspected and certified to at least a minimum standard before they can be shipped out of the Province where grown;
3. Potatoes sold and consumed within any Province are subject to the same grading package and marking regulations but they are under Provincial jurisdiction;
4. Federal inspectors, acting in a dual capacity and under separate authorization, enforce both Federal and Provincial regulations.

Grade Designation Required

In Canada, potatoes moving for fresh market purposes must be marked with a grade name at any level of trade, that is when first moving from the grower, packer or shipper; during transit; at wholesale or distributor level; and at retail level. Because the marking of a grade on all packages is mandatory it becomes the responsibility of the Governments to do all that is possible to see that the potatoes meet the requirements of the grade declared. No grade names other than those provided in either the Federal or Provincial regulations may be used and, since both sets of regulations have the same grade names and the same specified standards for the grades, we do not have the problem of determining equivalent standards.

We believe that a consumer has the right to expect to receive and receive the quality or grade of potatoes that is marked on the package regardless of what size of container may be offered at the final point of sale. We tried, through compulsory inspection, to accomplish this and undoubtedly we were at least partially successful. However, a fairly high percentage of the total crop is from relatively minor producing areas and of course there is always some local production adjacent to any marketing center. Potatoes from these areas do not get compulsory inspection and are subject to inspection only when found by an inspector at some level of trade but the entire blame for the poor retail offerings cannot be assessed against these two sources of the crop.

Studies during the 1951 and 1952 marketing seasons in some of our larger markets, produced evidence that perhaps we were relying too heavily upon our compulsory and voluntary shipping point inspection and certification which, although it has accomplished a lot, has not done all that we had hoped it would accomplish. It provides reasonable assurance, but not a guarantee that when a housewife purchases potatoes in a retail store they will be at least equivalent to the grade marked on the container. Due allowance can be made for off-condition but quite obviously part of the trouble lies in the application of tolerances at shipping point where grade defects can—within limits—be averaged over the lot. This may be fair and reasonable at shipping point but it cannot be used as a satisfactory explanation to a housewife who is unfortunate enough to purchase a below grade package of potatoes.

Retailer Responsibility

It was obvious that something more had to be done. Commencing in March, 1953, we set in operation a plan that approaches the problem

from an entirely different angle. We feel that all people, from grower to retailer, who are involved in marketing potatoes, have a responsibility to deliver correct grades to the consumer. Last, but not least, in the chain of handlers is the retailer and, very definitely, we feel that he must assume some responsibility. On the assumption that the retailer has some responsibility we have taken the stand that if he is placed in the position where he is penalized one way or another for offering for sale below-grade potatoes he will look to better service from his supplier and, if dissatisfied, will change his supplier. We feel that if you can get the retailer on your side the chain reaction soon works back to the packer.

"Detention" of Off-Grades

We have two ways of handling below grade produce. First, by the use of what we call a "detention"; and, second, by use of a violation report whenever court action is contempleted. Any commodity which fails to meet grade or other requirements can be placed "under detention" and it is unlawful to sell or move such detained produce without the authority of an inspector. When a detention is placed for any reason it means that the person having possession of the produce at that time is responsible for correcting the factors which were deemed to be of sufficient importance to warrant the placing of the detention.

Violation Report

Normally we do not permit detained produce to move back to the distributor or packer, the regrading must be done on the premises where detained. When we find that any person is persistently and consistently violating the regulations we have the option of issuing a violation report which more often than not forms the basis for court action. We place the retailer in the position of either having his potatoes meeting the grade marked on the container or having the entire lot detained for regrading.

As our inspectors visit retail stores careful reports are made on any lots of potatoes found below grade. When the report is complete we know what percentage of the containers were below grade, the percentage of defects in the container below grade and what defects were present in quantities exceeding the tolerances. We also know the name and address of the packer. This information is passed back to the inspectors working at shipping point who are in a position to watch closely the grading and packing operations of individual shippers.

Coverage Not Complete

We do not try to cover all Canadian markets and except in one city we do not claim to have complete coverage. We do feel though that our coverage is sufficient to cover the volume outlets in those centers where most consumers buy. We have been conducting our plan only since March, 1953, and we have noticed sufficient improvement in retail grades to encourage us in expanding our efforts and we have developed, on a trial basis, on one Western market—a retail inspection unit—responsible for nothing but retail inspection.

Four inspectors have been trained in the intricacies of the inspection of potatoes, butter, eggs, dressed poultry and allied products and it is the duty of these four men to inspect at retail level all the commodities mentioned and available in a store when they call. The activities of this unit and the results obtained have been watched with interest and, as a result, we are arranging to try the same program on the second largest Canadian market.

Fewer Offgrades Now

I mentioned earlier market surveys made in 1951 and 1952. Needless to say we were somewhat embarrassed to find in November, 1951, that an extremely high percentage of the potatoes in retail stores were below grade. In November, 1952, we found that those below grade had been reduced by approximately fifty per cent but still not within reasonable proportions. In March, 1953, we started the regular retail inspection visits and as of last September we find that we have worked the off-grade percentages down to a 5, to 11 per cent average over all markets.

All this sounds as though the whole procedure is very simple. Naturally, as with anything new there have been problems and administrative difficulties, but we feel that definite progress has been made. A year from now we will know more but, in the meantime, we are sufficiently encouraged by our efforts to consider an expansion of our program.

NEW YORK POTATO FIELD DAY

New York's potato growers will have their big day on Thursday, August 4th—date of the 22nd Annual Potato Field Day—an event which each year attracts more than 10,000 visitors.

It will be held this year on several farms near Bridgewater (Oneida County) on Route 8. Prof. M. W. Meadows, vegetable crops specialist at Cornell, is program chairman.

College of Agriculture experimental plots were established early this spring on the farm of Alois Wrobel. Some plots will show the effects of seed-borne virus diseases on plants and yield, while others have seed treated with antibiotics.

Cedar Brook Farms, run by Tony Kujawski and Steve Lonchek, and the Ray Simons farm will be host to 60 farm equipment dealers who will exhibit and demonstrate the latest in farm machinery and home appliances. Demonstrations include 30 of the latest design tractors plowing at the same time, and field trials of new "row-crop air blast sprayers" and newly improved stone-pickers. A tractor will be intentionally "tipped over" to show the causes of such accidents and illustrate the principals of tractor safety.

Phil Luke, of Fulton, president of the Empire State Potato Club, said a full program for the ladies is being planned. The selection of New York State's potato queen and a "spud peeling contest" are other highlights of the program.

ADVERTISING MANAGER SECURED

We are proud to announce the appointment of Don Koehnke Company, 203 Jackson Blvd., Chicago 4, Illinois as our advertising manager.

Don Koehnke and his father George will handle all advertising for the American Potato Journal as well as for the Supplement to be published this fall. All communications regarding advertising should be directed to them.

George Koehnke has had many years of experience in the advertising business and Don has recently returned from duty with the Armed Service. We have reason to believe that they will make an agressive effort to increase our advertising. Send the names of prospective advertisers to them and they will do the rest.

PENNSYLVANIA POTATO GROWERS FIELD DAYS ANNOUNCED

July 27th and 28th have been set for the Annual Pennsylvania Cooperative Potato Growers Field Days. This popular event will be held at Potato City located near Coudersport, Pa.

There will be demonstrations of farm machinery, a horseshoe pitching contest and a potato picking contest.

An important feature will be the election and coronation of the Pennsylvania Potato Blossom Queen.

A CONFERENCE ON BIOLOGICAL, PHYSICAL AND INDUSTRIAL ASPECTS OF POTATO IRRADIATION

A one day conference sponsored by the Brookhaven National Laboratory, Upton, L. I., N. Y., took place May 25 to discuss various aspects of potato irradiation. Experiments at Brookhaven and elsewhere have clearly demonstrated that irradiated potatoes will keep as long as 18 months without sprouting. In addition, certain other undesirable changes which normally occur in stored potatoes seem to be reduced. Since the process may be of early economic value the conference was called to permit up-to-the-minute reports by those actively engaged in all aspects of the problem

The meeting was attended by representatives of interested industrial organizations including processors of potato products; state and federal research personnel from all parts of the country as well as shippers and producers of potatoes.

Thirteen papers were presented on various aspects of the irradiation of potatoes. We plan to publish some of these papers in the American Potato Journal.

MYSTIK ANNOUNCES NEW SELF-STICK PRE-PACKAGING TAPE IN 6 COLORS!

Eye-catching color appeal plus extra safety and economy are the outstanding features of a new produce pre-packaging tape just released by Mystik Adhesive Products, Chicago.

At the same time, the firm announced the availability of a new inexpensive, counter-type dispenser for the tape designed to speed pre-packaging.

Mystik "Bag-Lok" Tape, as it has been appropriately named, is a completely new tape especially developed for instant sealing of polyethlene and all other film bags used in pre-packaging. It is available in standard ⅜" x 60-yard rolls, as well as jumbo 180-yard rolls designed for use in automatic closure equipment.

"Bag-Lok" Tape is available in six striking colors—red, white, blue, yellow, green and orange. The wide range of colors adds extra eye appeal to mass displays of pre-packaged produce, and other food-store items. Each day's or week's pre-packaging can also be color-coded—such as red for Monday, yellow for Tuesday, and green for Wednesday, etc.

Mystik's "Bag-Lok" Tape is safer, too—both for the packaging operator and the consumer. Fingers can't be cut nor closures lost inside the bag. "Bag-Lok" tape also reduces operator finger-fatigue and provides a neater, more attractive seal without untidy twists or torn bags. To open, the housewife simply zips off the tape—no broken nails or cut fingers. She can also re-use the bag for refrigerator and freezer storage.

Prices, simple rolls, and a 4-page folder in full natural color describing "Bag-Lok" Tape and its specially designed dispenser are available on request. Write to "Bag-Lok" Tape, Mystik Adhesive Products, 2635 N. Kildare Ave., Dept. P. J., Chicago 39, Ill. Mention this publication.

"COOK-FAX" FOR CONSUMER BAGS NEW UNITED SALES AID

Comes now "Cook-Fax," another sales aid for potato growers and handlers, to take its place along side the popular "Sack-Fax" introduced about three years ago by the Potato Division of the United Fresh Fruit & Vegetable Association.

"Cook-Fax" is a 4-page United brochure containing 23 new and proven potato recipes for back-printing or side-printing on consumer-size bags. Of course all 23 recipes cannot be printed on a five or 10-pound film bag, but they are numbered for easy selection and variety. For example page 2 of the brochure contains recipes for potato salads; page 3 soups and page 4 hot dishes. Each recipe has been kitchen tested by United's home economists.

The new sales aid will be provided to representatives of package manufacturers and sales agents, without charge, as a part of the United's contribution toward greater potato consumption. The only requirement is that the "Cook-Fax" be reproduced on bags exactly like the text, with necessary variations in size of type and printing styles.

"Sack-Fax," a list of ready-made potato-selling slogans for printing on larger bags, have appeared on some 100,000,000 bags since they were first introduced by the United three years ago. It is hoped that "Cook-Fax" will meet with similar response. Copies of "Cook-Fax" will be sent to packaging industry representatives on request to the United Potato Division.

HYPRO 150 PUMP INTRODUCED

Answering the growing needs for a greater capacity in the sprayer pump field is the Model 150, built for such agricultural applications as high volume spraying and rapid transfer of liquid fertilizer by Hypro Engineering, Inc., Minneapolis, Minn.

Capacity of the pump is over 30 gallons per minute at tractor power take-off speed (500 RPM), yet the Model "150" has a flow rate of over 65 gallons per minute at its maximum recommended speed of 1100 RPM. Highest suggested pressure limit is 150 pounds per square inch.

Case and rotor of the pump are available in cast iron or "Ni-Resist", a strong nickel -iron alloy having great resistance to wear and corrosion, the manufacturer states, and rollers are of resilient nylon for positive liquid displacement. The pump is self-priming and is equipped with permanently lubricated ball bearings.

The "150" may be mounted directly on a tractor PTO shaft or can be furnished with base plate and solid shaft for gas engine belt and pulley drive. Ports are 1½" in diameter.

The "150" is also suitable for regular weed, insect and cattle spraying, according to the manufacturer. For literature and price information, write Dept. KP, Hypro Engineering, Inc., 700 39th Ave. N. E., Minneapolis 21, Minn. Mention this publication.

THE 39TH ANNUAL MEETING
OF THE
POTATO ASSOCIATION OF AMERICA
in conjuction with
AMERICAN INSTITUTE OF BIOLOGICAL RESEARCH
Michigan State University
East Lansing, Michigan

SEPTEMBER 5-8, 1955

This is your invitation to attend our Annual Meeting

INFORMATION ON HOUSING

DORMITORY ACCOMODATIONS: College dormitories will be available for housing couples and families as well as single delegates. Accomodations will also be available in hotels and motels in and around the cities of Lansing and East Lansing. However, reservations for these accomodations will not be handled by MCU officials and arrangements must be made by individuals direct with the hotels and motels.

Hotel-type accomodations are provided in the Kellogg Center on the MSU campus. These rooms, however, are limited in number and assignment will be made on a first-come, first-served basis. Reservations may be made through Mr. J. D. Jackson whose address appears below.

DORMITORY ROOMS MAY BE OCCUPIED: Any time from noon on Monday, September 5 until 10:00 a.m. on Friday, September 9.

PRE-AND POST-MEETING HOUSING: Arrangements should be made individually by delegates through Mr. J. D. Jackson whose address appears below.

RESERVATIONS: Dormitories and Kellogg Center—May be made from now until September 2. Payment is to be made at time of registration on MPU campus.

RATES: Per person in *dormitories* (two persons assigned to a room), $3.00 per person the first night and $2.00 per person each additional night, with a maximum charge of $12.00 per week per person.

Per person in *Kellogg Center* (two persons assigned to a room), $3.50 per person per night.

ACKNOWLEDGEMENT: Each advance reservation received before August 27 will be acknowledged by a form which should be presented at the registration desk in September. Registration will be in the Main Lobby of the MSU Student Union.

MEALS: Those staying in regular College dormitories will take their meals in their "home" dormitory cafeterias. The cost will be $3.50 per day, payable in advance at time of registration. The cost of a missed cafeteria meal may be applied toward the cost of a banquet *if* arrangements are made during the registration period at a special "exchange" desk which will be provided for this purpose.

Those not wishing to take advantage of this "package" rate for meals may be served in the MSU Student Union Cafeteria on a direct cost per meal basis. However, each person making this choice should bear in mind two facts:

1. All delegates who select the individual, or "non-package," payment plan for their meals must be assigned to special dormitories set aside for this purpose.
2. The cost of meals on an individual, or "non-package," basis will be higher.

Delegates will pay for and receive banquet tickets at registration.

REGISTRATION: Student Union, Monday, September 5.

TO MAKE ADVANCE REGISTRATION: Please fill out the registration form and mail it to:

J. D. Jackson
AIBS
Continuing Education Service
Michigan State University
East Lansing, Michigan

TO FACILITATE ASSIGNMENT OF ROOMS: Those wishing to room together are requested to indicate this on the housing application form or on a note attached to the housing application form.

Please type or print all information

REGISTRATION AND HOUSING APPLICATION—MSU MEETING

Name ..... Male ☐ Female ☐
(first) (middle) (surname)

Home Address .....
(street)

.....
(city) (zone) (state)

Full Names, Sex, Relationship of Members of My Party:

.....

.....

.....

Professional Address: .....

Title: .....

Institution: .....

Society Membership:

(1) .....

(2) .....

(3) .....

Remarks: .....

.....

Expected Time of Arrival: .....
(date, hour)

Departure: .....
(date, hour)

Arrival: By Train ☐
By Plane ☐
By Car ☐

Please make reservations for me (and my party) in:

Dormitories with meals: (package rate) ☐

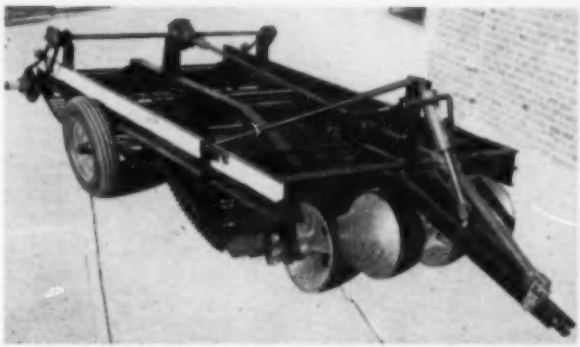
Dormitories without meals: (non package rate ☐

Kellogg Center: ☐

Top the Market with
Lockwood GRADERS
GERING, NEBR.

LOCKWOOD'S ALL NEW
TWO ROW LEVEL BED
POTATO DIGGER

- America's First Digger with Full 30' Beds.
- Equipped with Lockwood's Revolutionary Digger Chain.
- Can Easily Be Converted to a Stone Picker.



RUPERT, IDA. **LOCKWOOD GRADER CORP.** ANTIGO, WISC.
MONTE VISTA, COLO. GERING NEBR. GRAND FORKS, N. D.

Increased Stands, Bigger Yields, More Profits when Potato Seed Pieces Are Treated with

ORTHOCIDE
75 Seed Protectant

ORTHOCIDE not only protects potato seed pieces from seed rot and damp-off at planting, but this treatment continues its protective work *after* planting. Result—*much greater production*—growers report from 17% to 100% increase in stands! Also potato seed pieces dipped in an ORTHOCIDE 75 Seed Protectant dilution can be held several days without deterioration—thus enabling growers to cut pieces in advance of planting, without costly, time-consuming interruptions to cut more pieces.

CALIFORNIA SPRAY-CHEMICAL CORP.
Richmond, Calif.
Offices Throughout U. S. A.
TM'S ORTHO, ORTHOCIDE REG. U.S. PAT. OFF.

ORTHO

University Microfilms
313 North 1st St
Ann Arbor Michigan

CERTAINLY it pays to package in film made of BAKELITE Polyethylene

Packaging supplied by **Comet Packaging and Paper Company, Inc.,** New York, N. Y. from film made of BAKELITE Polyethylene by **Chester Packaging Products Corp.,** Yonkers, N. Y.

"why are potatoes like apples...?"

Easy. They both sell far better when packaged in film made of BAKELITE Brand Polyethylene. Look what Chazy Orchard, Chazy, N. Y., largest McIntosh orchard in the world, does:

Last season, according to Donald F. Green, manager, Chazy packaged nearly 33,000 bushels of apples in polyethylene. Now, with practically no exceptions, "all the apples we put into stores are sold—no returns. And we guarantee sales . . . take out any unmerchandisable fruit each week and replace with fresh. We used to have about 5% returns. Now they are nil practically."

You can get similarly fine results with potatoes. Packaging in bags made of film produced from BAKELITE Polyethylene is the soundest sales-building treatment you can give a crop. Talk to your packaging supplier today. He'll tell you how better prices right down the line are in store for you . . . when you market your produce in film made of BAKELITE Polyethylene.

REMEMBER: Farm water pipe is another wonderful product made from BAKELITE Polyethylene. It saves you time and money . . . lets you have water everywhere you need it.

BAKELITE
BRAND
Polyethylene Plastic

BAKELITE COMPANY,

A Division of Union Carbide and Carbon Corporation UCC 30 E. 42nd St., New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC